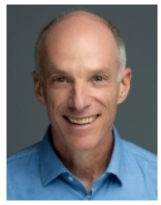
RESEARCH BRIEF
Start Date: Jan 28 2022 | Duration: 24 months

NAWI
National Alliance for Water Innovation

Electrochemical Advanced Oxidation



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Challenge

Two approaches are commonly used to treat trace organic contaminants: sorbents (e.g., activated carbon) and Advanced Oxidation Processes (AOPs). Sorbents produce waste that can be challenging to manage in distributed treatment systems, and also tend to be less effective in the removal of polar, low molecular weight contaminants (e.g., 1,4-dioxane, 1,2,3-trichloropropane) that frequently contaminate water supplies. The UV/H_2O_2 process is the most popular AOP for water recycling, groundwater remediation, and industrial wastewater treatment because it does not produce toxic byproducts or otherwise diminish water quality.[1] However, commercially available AOP systems are difficult to use at small-scale because they require frequent replenishment of reagents (e.g., H_2O_2), the submersed UV lamps are expensive, and the quartz sleeves are prone to fouling. Development of an economic AOP system tailored for distributed systems could fill in technology gaps and enable pipe parity for untapped, non-traditional water resources.

Research Approach

This research project will investigate an inexpensive, 3-electrode system to simultaneously degrade organic contaminants while simultaneously disinfecting water. The three key steps in the process (e.g, anodic oxidative treatment; O_2 reduction at the cathode[2]; and H_2O_2 conversion to hydroxyl radical on a stainless-steel mesh electrode[3]) will be studied separately to optimize performance and assess factors determining electrode lifetimes. Then, all three electrodes will be combined in a treatment module, with the goal of optimizing the system as a whole. Throughout these activities, team members will work together closely to coordinate the conditions being evaluated, share insights on materials characterization, and evaluate potential trade-offs involved in optimizing the separate stages of the process.

Impact

Successful completion of this project will support future development of autonomous, fully electrified, modular AOP systems that outperform existing alternatives, advancing many of the NAWI A-PRIME research areas of interest and enabling pipe parity. This research project also has the potential to intensify treatment by replacing several existing treatment technologies that are routinely employed in small-scale systems, such as household-scale water recycling, treatment/recycling of industrial wastewater, and treatment of contaminated groundwater. Lastly, the anticipated resiliency of the electrodes makes this systems particularly attractive in locations where existing treatment systems are impractical.

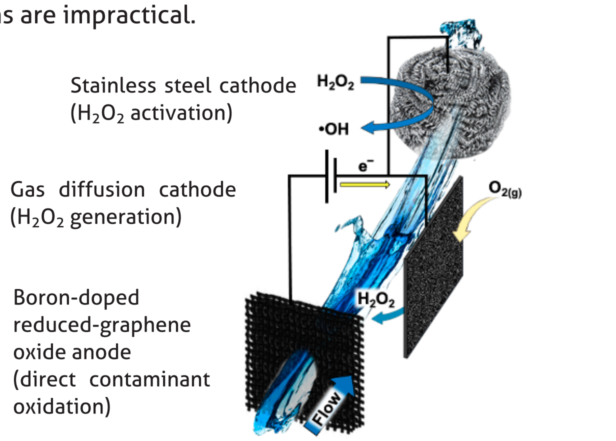

Figure 1. Schematic of the envisioned 3-electrode system for simultaneous contaminant oxidation and in-situ hydrogen peroxide generation.

RESEARCH PARTNERS

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REFERENCES

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2. Barazesh, J. M.; Hennebel, T.; Jasper, J. T.; Sedlak, D. L., Modular Advanced Oxidation Process Enabled by Cathodic Hydrogen Peroxide Production. Environmental Science & Technology 2015, 49, (12), 7391-7399.
3. Weng, C.; Chuang, Y.; Bradley, D. and Mitch, W.A. Reductive Electrochemical Activation of Hydrogen Peroxide as an Advanced Oxidation Process for Treatment of Reverse Osmosis Permeate during Potable Reuse. Environmental Science & Technology 2020, 54, (19), 12593-12601.

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